Example Project: Balance Beam

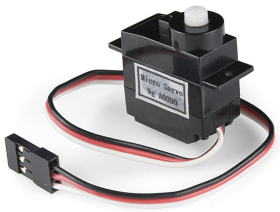
Collect Materials

The materials list for this project is a little more specific in terms of requirements. With this packet you should receive a drawing that gives you templates for pieces to cut out of cardboard as well as a template for bending a paper clip. The other materials are for final assembly. If you find other materials that will work similarly please go ahead and use them. These are what we have found to work best.

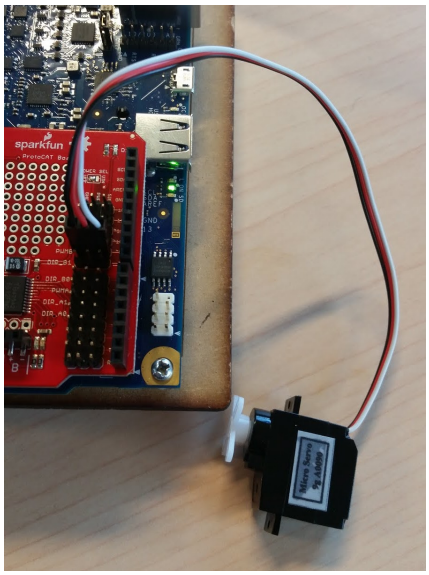
Cardboard	**Drink Straw**	**Construction Paper**
Paper Clip	**Wood Skewer**	**Milk Jugs**

Hooking up a Servo

Note: *Your Galileo should be unplugged at this time.*



A servo is an interesting little motor. Unlike a basic electric motor which will continuously turn when you power it, a servo motor will only rotate a certain number of degrees. What's even cooler is that you can tell the servo what angle to turn to and then stay there. Servos are amazing little motors that you can find in things from RC cars and airplanes to robots and automated control systems.



A servo motor has 3 wires coming out of it. The servo you have has wires that are black, red and white. You can probably guess that black and red are Ground and Power while white is your signal wire. You control a servo by sending it a signal pulse, basically turning the signal wire on and off really, really fast. This is called Pulse Width Modulation (PWM). Depending on how fast or slow the PWM is, the servo will turn to a specific angle.

Hooking up a servo is really easy using the Proto CAT Shield. The only catch is that servos will only work on specific output pins. Only pins 11, 10, 9, 6, 5 and 3 are designated as PWM pins that you can use a servo with. For now, just use row 9. When plugging the servo in make sure that the black wire from the servo matches up with GND pin (most inside pin) of the row. Now you have hooked up your servo! Reference your placemat for a wiring diagram to check your work.

Analog vs. Digital

In the night light project you turned something on and off, and that is digital. Digital means that there are two states of something; on or off, 0 or 1, true or false. On the other hand analog means that things can be on or off and a range of values in between. Think of the differences between a standard light switch and a dimmer switch in your house, and that is digital vs. analog. The Galileo takes an analog value as an input, in fact that is what the A stands for on the inputs pins. But, it does not have a true analog output. Galileo and most other controller boards use PWM to fake or approximate an analog output just like the light box project when you used sensor values to control the brightness of an LED. This approximation can also be used for rotation angle of a servo.

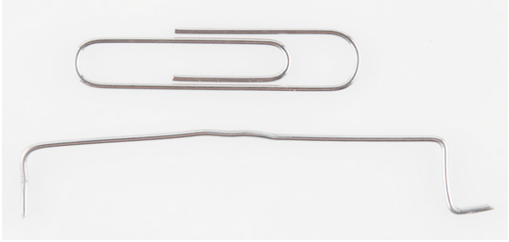
Controller Mode or Input

Go ahead and power up your Galileo once you have the servo wired. Remember to be patient and wait for the wireless network to appear and connect to it. Once you navigate to cat.com go ahead and click on the green plus sign to add an output. Select 9 and click OK. Once you are back in Configure Mode double click on the pin 9 output. You can name the pin if you would like. The most important thing is to select the Servo check box. This lets CAT know that a servo is attached to the pins and it will act appropriately. Select OK and then go to controller mode. You can now see that instead of 9 being a button (digital) it is a slider (analog). As you move the slider back and forth, the servo should rotate to given angles.

You now have a way to control a servo from your wireless device! If you want to you can also attach an input to this PWM (analog) output and it will match whatever the sensor value is. So, if you want a servo to move based on the noise level in the room, you can!

Now that you have a servo up and running go ahead and actually unplug your Galileo for now. You will be spending some time assembling your balance beam, and you don't want to leave the servo under power for so long.

Paper Clip Linkage



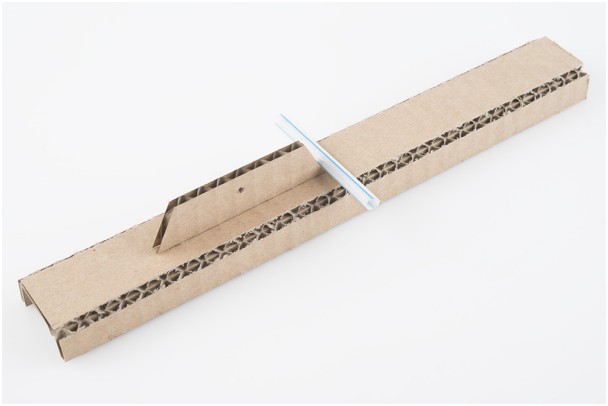
You are going to be using the servo to move a balance beam up and down. You can't really do this directly without using some type of linkage. A linkage is a way to connect an one type of motion to a different type of motion. In this example you are going to make a linkage that will translate the rotational motion of the servo to linear motion to

move the balance beam up and down. You can build this by bending a paper clip into the correct shape. The end with two 90 degree bends goes through a hole in the horn (the white part that spins) of your servo. The end with the single 90 degree bend will be taped to the bottom of your balance beam.

Balance Beam Assembly

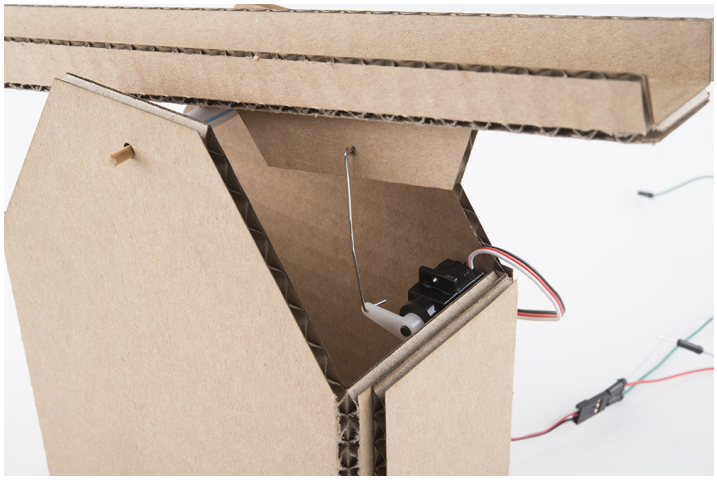
Your teacher should hand you some sheets that have dimensioned templates to cut parts out of cardboard. You can either cut these out and trace them or draw them by hand using the given dimensions. It is up to you or your teacher to choose which way to do it. When you have all of your parts cut out they should look something like the image below.

To assemble the base of the balance beam go ahead and bend the two pieces at the dashed lines on the templates and glue them together as shown. I highly recommend using hot glue for this as it will cool and dry quickly. The next step is to score and bend the beam sides and glue the linkage mount to the bottom as shown in the image below. At this time you can also add a length of a drink straw that is just a little shorter than the length of the width of the base. Make sure you get this as centered and straight as possible.



Once everything cools and hardens go ahead and attach the beam to the base. Use a length of skewer as an axle fulcrum through the base and the drink straw on the beam. The beam should pivot on the skewer freely.

The last step is to mount the servo inside of the base. Find the side that has the linkage mount on it and lightly glue the servo motor inside of the base as shown in the image. You may have to hold it in place for a while so that it doesn't slide out of position. Once solidly in place go ahead and add the paperclip to the beam and attach it to the motor.



Now you can plug your Galileo back in and follow the previous setup sequence. Pin 9 should be saved as a servo, and any other changes you previously made should have been saved. In Controller Mode you can control the balance beam with the slider. Find a marble and see if you can keep it on the balance beam. Can you pass it off to a class mate's balance beam?

Explore…

- Try using a sensor to control your balance beam
- Can the entire class pass a marble from one end of the room to the other?
- What else could you build that puts a servo and a linkage to use?